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DESENSITIZATION OF EXPLOSIVE MATERIALS.

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## INTRODUCTION AND SUMMARY

The objective of our work is to determine the generality of an observation that substitution of fluorine for hydrogen in an explosive material leads to desensitization. Substitution of the  $-\text{CH}_2-$  group in FEFO,  $[\text{FC}(\text{NO}_2)_2\text{CH}_2\text{O}]_2\text{CH}_2$ , with a  $-\text{CF}_2-$  group to give DFF,  $[\text{FC}(\text{NO}_2)_2\text{CH}_2\text{O}]_2\text{CF}_2$ , reduces the sensitivity to impact and low velocity detonation (LVD). In addition to having reduced sensitivity, DFF has higher density and lower melting point than FEFO.<sup>1</sup> To generalize our hypothesis that the substitution of fluorine for hydrogen will desensitize an explosive, first we are preparing formals analogous to FEFO and DFF and determining their sensitivity characteristics to be followed by fluorine analogs of explosive nitrate esters, heterocyclics and other classes.

In this report period,  $[\text{C}(\text{NO}_2)_3\text{CH}_2\text{O}]_2\text{CF}_2$ , compound 8,<sup>†</sup> was prepared for comparison with  $[\text{C}(\text{NO}_2)_3\text{CH}_2\text{O}]_2\text{CH}_2$ , compound 7. Also, the synthesis of HADDF,  $[\text{FC}(\text{NO}_2)_2\text{CH}_2\text{OCH}_2\text{OCH}_2]_2\text{C}(\text{NO}_2)_2$ , compound 13, was begun for comparison of the chemical and physical properties with ADDF,  $[\text{FC}(\text{NO}_2)_2\text{CH}_2\text{OCF}_2\text{OCH}_2]_2\text{C}(\text{NO}_2)_2$ , compound 14.

<sup>1</sup>J. M. Guimont and H. M. Peters, "Desensitization of Explosive Materials", Monthly Report No. 1, July 2, 1976.

<sup>†</sup>Numbers refer to compounds listed in Table 1.

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Table 1

## LINEAR FORMALS AND DIFLUOROFORMALS

| (RO) <sub>2</sub> CH <sub>2</sub> (Formals) |     |   | (RO) <sub>2</sub> CF <sub>2</sub> (Fluoroformals) |     |   |
|---|-----|---|---|-----|---|
| Compound                                    | No. | Structure   | Compound  | No. | Structure   |
| FEFO  | 1   | [FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> O] <sub>2</sub> CH <sub>2</sub> <sup>*</sup>   | DFF   | 2   | [FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> O] <sub>2</sub> CF <sub>2</sub> <sup>*</sup>   |
| DNPF  | 3   | [H <sub>3</sub> CC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> O] <sub>2</sub> CH <sub>2</sub> <sup>*</sup>                                      | NPFF  | 4   | [H <sub>3</sub> CC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> O] <sub>2</sub> CF <sub>2</sub> <sup>*</sup>                                      |
| TDPF  | 5   | [CF <sub>3</sub> OCH <sub>2</sub> C(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> O] <sub>2</sub> CH <sub>2</sub> <sup>*</sup>                     | OTT   | 6   | [CF <sub>3</sub> OCH <sub>2</sub> C(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> O] <sub>2</sub> CF <sub>2</sub> <sup>*</sup>                     |
| TEFO  | 7   | [C(NO <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> O] <sub>2</sub> CH <sub>2</sub> <sup>*</sup>  | †   | 8   | [C(NO <sub>2</sub> ) <sub>3</sub> CH <sub>2</sub> O] <sub>2</sub> CF <sub>2</sub> <sup>*</sup>  |
| †   | 9   | FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> OCH <sub>2</sub> C(NO <sub>2</sub> )F <sub>2</sub> <sup>*</sup>                  | MFF   | 10  | FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> OCH <sub>2</sub> C(NO <sub>2</sub> )F <sub>2</sub> <sup>*</sup>                  |
| †   | 11  | FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub> <sup>*</sup>                                    | TMFF  | 12  | FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> OCH <sub>2</sub> CF <sub>3</sub> <sup>*</sup>                                    |
| †   | 13  | [FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> OCH <sub>2</sub> ] <sub>2</sub> C(NO <sub>2</sub> ) <sub>2</sub> <sup>*</sup>   | ADDF  | 14  | [FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> OCH <sub>2</sub> ] <sub>2</sub> C(NO <sub>2</sub> ) <sub>2</sub> <sup>*</sup>   |
| †   | 15  | FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> C(NO <sub>2</sub> ) <sub>2</sub> F <sup>*</sup> | HTD   | 16  | FC(NO <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OCH <sub>2</sub> CF <sub>2</sub> OCH <sub>2</sub> C(NO <sub>2</sub> ) <sub>2</sub> F <sup>*</sup> |

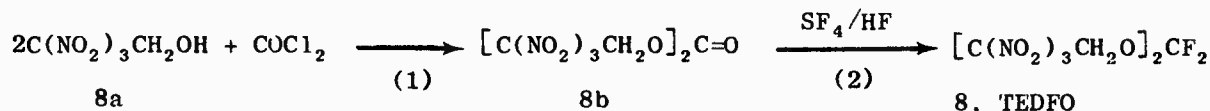
\* Site of change.

† Not previously reported.

## DISCUSSION OF RESULTS

### Comparison of $[C(NO_2)_3CH_2O]CF_2$ , compound 8, with $[C(NO_2)_3CH_2O]CH_2$ , compound 7 (TEFO)

We prepared bis(trinitroethyl) difluoroformal, compound 8, by the route shown in Eqs. 1 and 2.



The carbonate, 8b, prepared during the previous report period, was fluorinated in a high pressure reactor using sulfur tetrafluoride with anhydrous hydrofluoric acid as catalyst and solvent. The results of the five trials are shown in Table 2. Based on our previous experience with sulfur tetrafluoride, we expected the reaction temperature to be the most critical parameter. The results of trials 2, 4, and 5 showed that reaction temperature is important but that other parameters may be equally so. Since the conditions of trial 5 produced about 75% conversion to the desired product, 8, we plan to force the reaction to completion by repeating trial 5 at 105°C on a larger scale using a longer reaction time.

A complete physical property determination of compound 8 is in progress.

### Comparison of ADDF with HADDF

We also began the synthesis of the hydrocarbon analog (HADDF, compound 13) of ADDF for comparison of sensitivity properties. In one approach, fluorodinitroethylchloromethyl ether was treated with 2,2-dinitropropane-1,3-diol in the presence of stannic chloride as catalyst, Eq. 3.

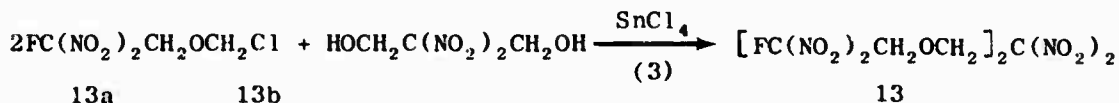


Table 2



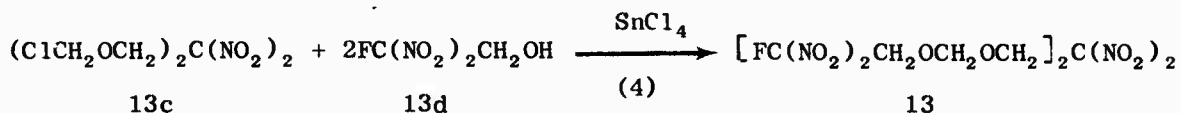
| Trial | Carbonate<br>(g/mmol) | HF<br>mmol | SF <sub>4</sub><br>mmol | Temp.<br>°C | Time<br>hrs | Product<br>(g) | Remarks  |
|-------|-----------------------|------------|-------------------------|-------------|-------------|----------------|--|
| 1     | 10/48                 | 100        | 157                     | 90          | 20          | 9.5            | Starting material recovered                    |
| 2     | 10/48                 | 1100       | 102                     | 90          | 20          | 9.2            | Starting material recovered                    |
| 3     | 10/48                 | 1300       | 74                      | 120         | 20          | 9.2            | Starting material plus small amount<br>product |
| 4     | 10/48                 | 1300       | 102                     | 120         | 120         | 0.8            | Primarily decomposition                        |
| 5     | 10/48                 | 1100       | 194                     | 105         | 72          | 9.4            | 75% Product, 25% starting material             |

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\*Product identification is based on ir and nmr analyses.

The mixture of reaction products is currently undergoing separation and identification.<sup>2</sup>

Similarly in a second approach, 1,3-bis(chloromethyl)-2,2-dinitropropyl ether was treated with fluorodinitroethanol Eq. 4.



Again, a mixture of products was obtained. Although bis(fluorodinitroethyl) formal,  $[\text{FC}(\text{NO}_2)_2\text{CH}_2\text{O}]_2\text{CH}_2$ , and 5,5-dinitro-1,3-dioxane,  $(\text{NO}_2)_2\text{C}\overbrace{\text{CH}_2\text{OCH}_2\text{OCH}_2}^{\text{5,5-dinitro-1,3-dioxane}}$ , have been identified as reaction products of both attempted reactions, the presence of Compound 13 has not yet been confirmed. The product analyses of the two reactions, Eq. 3 and 4, have not been completed and are continuing because we believe that some of compound 13 was formed and can be isolated. Other workers have obtained mixtures from chloromethyl ether reactions with similar electronegatively substituted alcohols.<sup>3</sup>

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<sup>2</sup>G. W. Lawrence, L. E. Kayser, and H. G. Adolph, "ALWT - High Energy Plasticizer and Binder Synthesis", Final Report, February 15, 1976.

<sup>3</sup>H. G. Adolph and M. J. Kamlet, J. Org. Chem., 34, 45 (1969).

#### FUTURE WORK

During the next report period we plan to characterize and prepare in quantity  $[\text{C}(\text{NO}_2)_3\text{CH}_2\text{O}]_2\text{CF}_2$ , compound 8, and begin testing its sensitivity for comparison with compound 7 (impact, hVD, LVD).

We also plan to complete the characterization of the products of the chloromethyl ether reactions, Eq. 3 and 4, and to continue our investigation of the synthesis of compound 13,  $[\text{FC}(\text{NO}_2)_2\text{CH}_2\text{OCH}_2\text{OCH}_2]_2\text{C}(\text{NO}_2)_2$ .

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>The objective of our work is to determine the generality of an observation that substitution of fluorine for hydrogen in an explosive material leads to desensitization. Substitution of the $-CH_2-$ group in FEFO, $[FC(NO_2)_2CH_2O]_2CH_2$ , with a $-CF_2-$ group to give DFF, $[FC(NO_2)_2CH_2O]_2CF_2$ , reduces the sensitivity to impact and low velocity detonation (LVD). In addition to having reduced sensitivity, DFF has higher density and lower melting point than FEFO. To |                       |   |                       |

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19. KEY WORDS (Continued)

Trinitroethyl difluoroformal (TEDFO)  
Replacement C-H by C-F  
Reduced low velocity detonation (LVD)  
High Velocity Detonation (HVD)  
Impact Sensitivity  
ADDF versus  $-CH_2-$  ADDF

20 ABSTRACT (Continued)

generalize <sup>the</sup> ~~our~~ hypothesis that the substitution of fluorine for hydrogen will desensitize an explosive, first ~~we are preparing~~ ~~formals~~ ~~analogous to FEFO and DFF\*~~ and determining their sensitivity characteristics. ~~to be followed by fluorine~~ analogs of explosive nitrate esters, heterocyclics and other classes.

\* are being prepared

xx This research will continue on